from timepoint to timepoint. Stacked cumulative percent plots can be applied to diverse disease types and to outcomes with varying amounts of anticipated change from timepoint to timepoint.

PMC3

USING FRONTIER ANALYSIS TO OPTIMIZE THE OVERALL LIFE YEARS GAINED IN VACCINATION POLICY OF INFECTIOUS DISEASES

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OBJECTIVES: The aim of the study is to utilize the novel frontier analysis to search for optimal strategy of vaccination policy against infectious diseases with limited vaccine supply. **METHODS:** An important goal of public health research is to predict clinical impact by nation-wide mass vaccination in preventing infectious diseases. Vaccination is usually given across potential vulnerable populations such as children. However, due to limited resources provided by the government among a growing number of competing vaccine products, some vaccinations are to be given to some targeted high-risk cohorts against infectious diseases, such as pneumonia or influenza. Hence, the optimal strategy of vaccination policy for effective disease control becomes a practical concern. We propose a model using frontier analysis to seek the optimal vaccination policy in controlling infectious disease epidemics with limited resources. The problem is initially formulated to find the maximal life years gained while minimizing the variance. Various vaccination policies were explored in finding the optimal vaccination strategy. The indirect effects on unvaccinated cohorts were also considered in the analysis. The technique is illustrated using pneumococcal conjugate vaccine (PCV) in Taiwan as an example. **RESULTS:** Using the empirical study of PCV and various scenarios of the policy with limited resource, we provide the best vaccination strategy among various defined cohorts and report the maximal life years gained with the fixed total cost of the vaccine given. Our study can be generalized to the optimization of vaccination strategies for most infectious diseases among different population structures. **CONCLUSIONS:** When disease burden is high, more emphasis should be laid on the possible health benefits gained with a vaccination program, instead of just considering the economic benefits. Our study can help to guide decision makers in determining optimal uses of limited quantities of vaccine across multiple targeted cohorts to effectively control infectious diseases.

PMC4

A FRAMEWORK FOR DEVELOPING A FLEXIBLE CONTROL–BASED ASTHMA POLICY MODEL

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OBJECTIVES: The goal of asthma management is to gain and maintain control. Several validated patient-reported measures are available to assess the degree of control: Asthma Control Questionnaire (ACQ), Asthma Control Test (ACT), and the Asthma Therapy and Assessment Questionnaire (ATAQ). We propose a flexible and transparent model structure that represents disease variability through exacerbation rates and any one of the three control instruments. **METHODS:** We developed a Markov model to simulate cohorts transitioning among six health states: an asthma control continuum state (variability in control is tracked using one of the three control instruments), three severity levels of asthma exacerbation, and asthma and non-asthma related death. To estimate the cost and outcome weights for the control continuum state, we explored the relationship between the ATAQ (higher ATAQ = less control) and management costs (including absenteeism costs) and utilities using a large asthma registry of exacerbation-free patients. A hypothetical asthma intervention added to standard-of-care was compared to standard-of-care alone as summarized by the following product profile: a 50% reduction in asthma exacerbation rates, a 0.5 absolute improvement in the ATAQ score, and an additional $10,000 per annum intervention cost. **RESULTS:** The estimated change in bi-weekly asthma management costs for a one unit increase in the ATAQ score was $36.12 (robust SE = $3.95) and for utilities was –0.05 (robust SE = 0.0041). Assuming a five year time horizon, the hypothetical intervention plus standard-of-care had an incremental mean cost of $25,800 (95% interval $10,600, $41,000), quality adjusted life year (QALY) of 0.257 (0.106, 0.435), and cost per QALY of $100,500/QALY ($13,700, $199,800). **CONCLUSIONS:** As relationships emerge between any of the instruments of control and costs and utilities, this versatile model can forecast: long-term burden of disease, value of existing and emerging interventions, and inputs that yield the highest return from further study.

PMC5

PRO AND UTILITY ASSESSMENT: ADDRESSING CONFOUNDS OF CHANGING SELF–REFERENCE

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Identity, the view of self-reference, is not static across populations and is probably not stable within an individual over time. Philosophers, psychologists and the religious continue to offer support for particular points of view of identity but there are many differences among them. These differences seem quite able to bias utility and patient-reported outcomes assessments. As such, care must be taken to understand the self-reference schemas of the population within which self-assessments are validated and used. Some of the options people have and use for self-reference are: 1. operational (e.g., I am a clinical researcher or a father), 2. preference-oriented (e.g., I am a lover of wine or a "runner"), 3. physical (e.g., I am my body), 4. psychological (e.g., I am my ego), 5. religious (e.g., I am spirit) and 6. philosophical (e.g., I am thinking, I am consciousness, no such thing as identity exists, I am subjective experience). It's surprising self-assessments are conducted when we don't know who is responding to our questions. The confound of identity is important to study in its own right because of how strongly it can influence public policy through research findings based on self-assessments. "View of self-reference" seems a fundamental and necessary element for inclusion into requirements for construction and validation of PROs. Otherwise, instrument bias could be specifically used to make a certain claim, much like regression towards the mean could be used if it was not previously identified as a threat to validity. That identify may shift over time within an individual, say from an external focus to an internal focus, may be the reason why some terminally ill patients report good quality of life despite their poor health. When the body is not a factor in one's identity, what is the meaningfulness of health-related quality of life anyway?

PMC6

META–REGRESSION AS A METHOD OF IDENTIFICATION OF THE CAUSES OF HETEROGENEITY BETWEEN STUDIES ON THE EXAMPLE OF RELATIONSHIP BETWEEN SURROGATES AND CLINICALLY IMPORTANT ENDPOINTS IN TYPE–2 DIABETES MELLITUS

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OBJECTIVES: Use of meta-regression to explain heterogeneity between the studies evaluating relationship between the level of glycated hemoglobin (HbA1c) and the risk of development of retinopathy in patients with type 2 diabetes mellitus (DMT2). In meta-regression the results of the studies under consideration are treated as points to be analyzed by weighted regression. If the results obtained in a model without covariates indicate heterogeneity of studies, then inclusion of subsequent covariates into the model can make it possible to check if specific variables explain heterogeneity. The amount of heterogeneity may be expressed as between-study variance. If between-study variance decreases after inclusion of a specific covariate into the model, it means that heterogeneity between the studies may be explained by that covariate. **METHODS:** The following covariates were considered: observation period, type of the study, sample size, HbA1c level, age, duration of DMT2, BMI, cholesterol level, arterial blood pressure. Due to a scarce number of studies available between-study variance was estimated using the REML method. The value of between-study variance evaluated using a meta-regression model for retinopathy in DMT2 without covariates was 0.4547. **RESULTS:** Inclusion of the difference between the intervention group and the control group with respect to the HbA1c level resulted in decrease to 0.1572. Therefore the covariate under consideration explains the heterogeneity in 65.4%. The obtained value of directional coefficient was statistically significant and equal to 0.5824, which means that increase of difference between the groups with HbA1c level by 1 unit results in increase of the logarithm of relative risk by 0.5824, reflecting increase the risk by 1.79 times. **CONCLUSIONS:** It was demonstrated using meta-regression that the difference with respect to the HbA1c level is the cause of heterogeneity between the studies. Relative risk of development of retinopathy increases with increase of the difference in HbA1c level.

PMC7

EFFECTS OF HETEROGENEITY ON THE ESTIMATION AND COMPARISON OF MEDICATION ERROR RATES

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OBJECTIVES: The clinical consequences and costs of medication errors (ME) have significant implications on quality of care. A detailed understanding of the occurrence and patterns of MEs is critical to reducing ME rates and improving patient outcomes. However, ME rates are often estimated inaccurately. ME rates are typically heterogeneous with respect to hospitals and units within hospitals, because of differences in health care provider (HCP) experience and skill. Although this heterogeneity has important implications for the precision and power of ME analysis, it is seldom taken into account in the estimation of MEs. **METHODS:** To evaluate the effects of heterogeneity on the precision and power of estimated ME rates, we assumed three sources of heterogeneity: hospital, unit (or HCP) within hospital, and random error. We derived formulas representing the variances of the estimated ME rates and the variances of comparisons of ME rates, and graphically illustrated the effects of sample sizes and magnitude of heterogeneity on the variances. **RESULTS:** The heterogeneity associated with hospital and unit induces clustering of MEs within hospitals and units, increasing variability in the estimated ME rates compared with what would be observed in the absence of heterogeneity. Even in the presence of low levels of heterogeneity, the variances of the estimated ME rates can be substantially increased. Power associated with comparisons of ME rates also can be substantially affected with decreased power for comparisons between hospitals or units and increased power for comparisons within hospitals or units. **CONCLUSIONS:** Heterogeneity of MEs with respect to hospitals and hospital units (or HCPs) can have a substantial effect on precision and power, and should be incorporated in the analyses ME rates. We provide precision and power formulas for planning future studies of MEs.